Fall 2008

# Hospital Costs for Acute Myocardial Infarction Patients Receiving Perfect Compliance of Evidence-Based Care Bundle

Jill S. McCormick
*Regis University*

**Regis University**
Rueckert-Hartman College for Health Professions
**Final Project/Thesis**

# Disclaimer

# HOSPITAL COSTS FOR ACUTE MYOCARDIAL INFARCTION PATIENTS RECEIVING PERFECT COMPLIANCE OF EVIDENCE-BASED CARE BUNDLE

by

Jill S. McCormick

A Master's Thesis Presented in Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Health Service Administration

Regis University

December, 2008

**FINAL APPROVAL OF MASTER'S PROJECT**
**HSA696 MASTER'S PROJECT**

I have **READ AND ACCEPTED**

the Master's Project by:

Jill S. McCormick

Hospital costs for acute myocardial infarction patients receiving perfect compliance of evidence-based care bundle

Submitted in partial fulfillment of
requirements for the
Master of Science in Health Services Administration
degree at
Regis University

Primary Research Advisor: Michael Cahill MS

Date: December, 2008

Abstract

An estimated 565,000 new myocardial infarctions and 300,000 recurrent myocardial infarctions will occur each year (AHA, 2006). This study sought to find if there was a difference in hospital costs between those acute myocardial infarction patients that received 100% of eligible core measures (evidence-based care bundle) and those that did not. There is limited research on actual hospital costs (vs. charge data) for acute myocardial infarction evidence-based treatment in the United States. The results of the study did not show any statistically significant difference in hospital costs between those patients that received 100% of core measures and those that did not. Hospital costs were mostly driven by length of stay, APR-DRG severity and gender. The study did evidence a statistically significant difference in hospital costs between men and women that could not be explained by length of stay, age, race, APR-DRG severity or mortality. As more quality data is publicly reported and the Centers for Medicare and Medicaid Services places more finances behind reaching performance indicators evidence-based core measures will come under greater review.

Table of Contents

# Chapter 1: Introduction

The American Heart Association estimates the prevalence of 7,200,000 acute myocardial infarctions in the United States (American Heart Association, 2006). An estimated 565,000 new myocardial infarctions and 300,000 recurrent myocardial infarctions will occur each year (AHA, 2006). Heart disease, in which acute myocardial infarction is included, is the number one killer in the United States claiming 654,094 lives in 2004 (Levit, Ryan, Elixhauser, Stranges, Kassed, and Coffey, 2007). Sixteen percent of all hospital stays resulted from circulatory conditions (including coronary artery disease, congestive heart failure, heart attack and irregular heartbeat) (Levit, et al., 2007).

In 2006, direct medical costs of cardiovascular disease totaled $257.6 billion. Hospitalizations related to heart conditions comprise six of the twenty highest costing conditions for hospitals, making up 17% of all community hospital costs in 2005 (Levit et al., 2007). As a primary diagnosis, acute myocardial infarction represented 1.7% of all discharges in 2005 and was the ninth most frequent principal diagnosis for inpatient stays (Levit et al.). Acute myocardial infarction, as a principal diagnosis, ranked second in highest aggregate costs in 1997, 2004, and 2005, with total inflation-adjusted hospital costs of $8.7 billion, $11.6 billion and $10.9 billion, respectively. (Levit et al., p49). Between 1997 and 2005, the aggregate costs for stays in community hospitals had an average annual increase, after inflationary adjustment, of 5.1% per year for eight years (Levit et al.).

Tran (2004) points out the numerous studies of the quality of acute myocardial infarction care that have illustrated the underutilization of evidence-based treatment with proven efficacy, even after controlling for contraindications to the therapy. While increases in utilization of evidence-based cardioprotective medications (aspirin, β-blockers, angiotensin-converting

enzyme (ACE) inhibitors, lipid lowering agents and combinations thereof) have occurred over the past decade, there is still a great deal of opportunity (Spencer 2005). As the number of elderly increases sharply, the cost and quality of care for these individuals will be continuously scrutinized. The purpose of this study is to determine if there is a difference in hospital costs (total hospital costs, direct costs, indirect costs, fixed costs and variable costs) for those acute myocardial infarction patients that receive 100% of eligible core measures, "perfect score" and those that do not. Hospital costs do not include physician costs. The research question is: Is there a difference in hospital costs in those acute myocardial infarction patients that receive 100% of eligible core measures, "perfect score" and those that do not receive 100% of eligible core measures? The null hypothesis is: there is no difference in hospital costs for those acute myocardial infarction patients that receive 100% of eligible core measures, "perfect score" and those that do not receive 100% of eligible core measures.

*Medicare*

In 2005, the largest group of all acute myocardial infarction patients was between 65 and 84 years of age, 45.23% (Levit et al., 2007). According to the 2000 Census, there are nearly 35 million (34,991,753) people 65 years or older, representing 12.4% of the total United States population. According to the United States Census projections, the population of 65-84 year olds will increase 38.8% from 2010 to 2020 and the greater than 85 year old population will increase 18.7%. From 2020 to 2030 these groups are projected to increase 30.6% and 32.1%, respectively (US Census 2000). Medicare is a social health insurance for people over the age of 65, people of any age with End Stage Renal Disease (ESRD) and people under the age of 65 with specific disabilities (Hoffman, 2005). Medicare enrollment has increased nearly 125% since its inception in 1965. Medicare covers 95% of our nation's aged population, as well as the disabled. In 2004,

Part A (hospital expenses and specific other medical care) covered approximately 41 million beneficiaries with benefit payments of $167.6 billion (Hoffman, 2005). Medicare spending is projected to increase by nearly $425 billion between 2008 and 2017 (Keehan, Sisko, Truffer, Smith, Cowan, Poisal, et al., 2008). Only 12% of the population is currently over 65 years old, yet they make up 34% of all hospitalizations (Levit et al., 2007). 574 stays for every 1,000 over 85 adults took place in 2005 (Levit et al.).

*Core Measures-evidence-based care bundle*

The Medicare Modernization Act of 1997 required a Medicare Health Quality component. The resulting Medicare Health Quality Demonstration Project goals included: "improve safety; enhance quality of care by increasing efficiency; and reduce scientific uncertainty and unwarranted variation in medical practice that results in both lower quality and higher costs." (Mason, 2005, p.2). As a result of these demonstration projects and scientific review, evidence-based core measures for the treatment of acute myocardial infarction were developed. Table 1 details these core quality measures.

Table 1
*NQF-Endorsed Voluntary Consensus Standards for Hospital Care. Acute Myocardial Infarction Measure Information Form (AMI evidence-based care bundle)*

| *Core Measure* | *Description* |
|---|---|
| AMI-1: Aspirin at Arrival | AMI patients without aspirin contraindications who received aspirin within 24 hours before or after hospital arrival. |
| AMI-2: Aspirin prescribed at discharge | AMI patients without aspirin contraindications who are prescribed aspirin at hospital discharge. |
| AMI-3: ACEI or ARB for left ventricular systolic dysfunction (LVSD) | Angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) for LVSD. |
| AMI-4: Adult Smoking Cessation Advice/Counseling | AMI patients with a history of smoking cigarettes, who are given smoking cessation advice or counseling during hospital stay. For the purposes of this measure, a smoker is defined as someone who has smoked cigarettes anytime during the year prior to hospital arrival. |
| AMI-5: Beta Blocker Prescribed at Discharge | AMI patients without beta blocker contraindications who are prescribed a beta blocker at hospital discharge. |
| AMI-6: Beta Blocker at Arrival | AMI patients without beta blocker contraindications who received a beta blocker within 24 hours after hospital arrival. |
| AMI-7: Median Time to Fibrinolysis | Median time from arrival to administration of fibrinolytic agent in patients with ST-segment elevation or left bundle branch block (LBBB) on the electrocardiogram (ECG) performed closest to hospital arrival time. |

Table 1 (*continued)*.

| *Core Measure* | *Description* |
|---|---|
| AMI-7a: Fibrinolytic Therapy Received within 30 Minutes of Hospital Arrival | AMI patients receiving fibrinolytic therapy during the hospital stay and having a time from hospital arrival to fibrinolysis of 30 minutes or less. |
| AMI-8: Median Time to Primary PCI | Median time from arrival to percutaneous coronary intervention (PCI) in patients with ST-segment elevation or left bundle branch block (LBBB) on the electrocardiogram (ECG) performed closest to hospital arrival time. |
| AMI-8a: Primary PCI Received within 90 Minutes of Hospital Arrival | AMI patients receiving percutaneous coronary intervention (PCI) during the hospital stay with a time from hospital arrival to PCI of 90 minutes or less |

Adapted from: "Specifications Manual for National Hospital Quality Measures (Acute Myocardial Infarction) by Centers for Medicare and Medicaid Services and Joint Commission of Accreditations on Healthcare Organizations, Version 2.0 (2006, July).

*Increased pressure from external forces*

Centers for Medicare and Medicaid Services (CMS), The Joint Commission, and Institute of Health Improvement (IHI) 100,000 lives campaign have brought questions about quality core measures to a higher status among administrators and is forcing them to review and present data in a public forum. Furthermore, The American College of Cardiology and the American Heart Association have released evidence-based guidelines for the management of patients with AMI, thus increasing visibility from the physician side. The Medicare Prescription Drug, Improvement and Modernization Act of 2003 requires hospitals to submit data on AMI measures or they will

receive a 0.4% reduction in annual payment update from CMS for FY2005, 2006, and 2007 (CMS, 2008).

Donald Berwick, M.D., IHI President and CEO notes, "[t]he average care system is just pumping out scrap at a very high rate. That's where conventional ROI thinking ought to work… there's big money in getting it right" (Carpenter, 2006, p.26).

*Composite Score vs. "Perfect" Score*

There are two different measurements to determine adherence to the Centers for Medicare and Medicaid Services guidelines. The composite score is most often referred to and is utilized in most publicly reported data. The composite score focuses on the number of times an intervention takes place divided by the total number of opportunities to complete the intervention.

$$\frac{\text{Number of total interventions}}{\text{Number of possible interventions}} = \text{Composite Score}$$

Dr. Steven Corwin (2006), Cardiologist, Executive Vice-President and Chief Operating Officer of New York Presbyterian Hospital spoke of the Composite Score:

> The measurements look at each medicine individually. So results will show whether a patient received that medicine, which is a good measurement of adherence to accepted medical practices. A good measurement of quality, however, would look at the percent of patients who received every medicine that they should have received. (p.20)

The Appropriate Care Score (ACS) "Perfect Score" is a measure of the number of times patients received all the care for which they were eligible.

Appropriate Care Score "Perfect Score"=

$$\frac{\text{Total number of patients that received all the care for which they were eligible}}{\text{Total number of patients eligible for the focus area}}$$

Eligible for denotes no contraindications. The "Perfect Score" is the total number of patients that received all the care they were eligible for divided by the total number of patients eligible for the focus area (Premier, n.d.).

The efficacy of individual core measure therapies has been determined through many years of research and several studies (Antiplatelet Trialist's Collaboration, 1994; Brodie, Stuckey, Wall, et al., 1998; Flather, Yusuf, Kober, 2000; French, 2000; Jencks, Cuerdon, Burwen, et al., 2000; Krumholz, Anderson, Brooks, et al., 2006; Krumholz, Radford, Wang, et al., 1998). As the study is reviewing the perfect score (100% implementation of core measures vs. not 100% implementation of core measures) the literature review will review combination therapy, not individual therapies.

The combination of increased external pressures to report quality outcomes and healthcare consuming a larger share of the economy will lead to, "policymakers, insurers, and the public [facing] increasingly difficult decisions about the way that healthcare is delivered and paid for" (Keehan, et al., 2008, w154).

# Chapter 2: Literature Review

The purpose of this study is to determine if there is a difference in hospital costs for those acute myocardial infarction patients that receive 100% of eligible core measures, "perfect score" and those that do not. The research question is: Is there a difference in hospital costs in those acute myocardial infarction patients that receive 100% of eligible core measures, "perfect score" and those that do not receive 100% of eligible core measures? The literature review will review evidence-based combination cardioprotective therapies, hospital costs, and quality for treatment of acute myocardial infarction.

Medicare is the nation's largest purchaser of healthcare (Abelson, 2003). Historically, high quality and improved effectiveness have not been rewarded. In the 2004 Annual Report on the status of the Social Security and Medicare Programs indicated that the Medicare Hospital Insurance (MHI) trust fund had significantly deteriorated and is expected to continue the drastic deterioration after 2010 as Baby Boomers begin to retire. Estimates at that time predicted complete depletion by 2019 (Cleverly, 2004). Current estimates have Medicare funds "lasting" slightly longer than previously predicted, yet the introduction of Medicare Part D and other increases have led to projected increases in Medicare spending, 2008-2017 of nearly one quarter of a trillion dollars (Keehan, et al., 2008).

Cleverly comments that each provider [hospital] must provide high quality products and services efficiently and at a reasonable cost. Those that do not will see decreased financial performance. "While healthcare has some unique characteristics, it is not immune to basic economic forces" (Cleverley, 2004, p52). The current Medicare reimbursement environment is not aligned with acute myocardial infarction quality performance indicators. The literature suggests that there is a threshold of payment for increased quality of care in healthcare

organizations (Weech-Maldonado, 2003). While there is a trend to move towards more pay-for-performance mechanisms, it will not reduce the need to review costs.

*Mortality*

Mortality of patients varies widely in lower and higher quality performing organizations. Compliance with acute myocardial infarction guidelines has found to lower inpatient mortality (Szekendi, 2003). Szekendi (2003) found that "patients treated in facilities in the highest quartile had an average in-hospital mortality rate of 8.3%, while patients treated at hospitals in the lowest quartile had an average in-hospital mortality rate of 15.3%" (p. 359). Peterson et al. (2006) presented the first comprehensive study illustrating that acute myocardial infarction mortality rates were lower in hospitals that followed the AHA College of Cardiology (ACC/AHA) Guidelines for the management of patients with acute myocardial infarction. The Centers for Medicare and Medicaid Services (CMS) guidelines are closely aligned with those of the American College of Cardiology.

*Combination Therapy and mortality*

Combination cardioprotective medications have been shown to be associated with reduced risk of death. As illustrated in Table 2, 31% reduction in mortality risk was attained with aspirin use after adjusting for covariates. 56% improved survival was achieved with the aspirin and beta blocker group and 45% improved survival in the group with aspirin with beta blockers and ACE (angiotensin converting enzyme)-inhibitors when compared to those not prescribed any cardioprotective medications at discharge (Krause et al., 2004). More interestingly, the greatest survival advantage was made by those patients with the most advanced renal dysfunction.

Table 2
*Overall unadjusted and adjusted hazard ratios (HR) and 95% confidence interval for mortality after hospital discharge for acute myocardial infarction by cardioprotective medication group.*

| | Unadjusted HR (95% CI) | Adjusted HR* (95%) |
|---|---|---|
| No medications** | 1.00 | 1.00 |
| Aspirin alone | 0.79 (0.56, 1.12) | 0.69 (0.48, 0.99) |
| Aspirin and β-blockers | 0.39 (0.26, 0.57) | 0.44 (0.30, 0.65) |
| Aspirin, β-blockers, and ACE inhibitors | 0.60 (0.41, 0.87) | 0.55 (0.37, 0.81) |

Adapted from "Combination therapy improves survival after acute myocardial infarction in the elderly with chronic kidney disease," by Krause, M.W., Massing, M., Kshirsagar, A., Rosamond, W., & Simpson, R., 2004, *Renal Failure*, 26, p.720.
*Adjusted for age, race, gender, history of diabetes mellitus, hypertension, congestive heart failure, anterior MI location and level of chronic kidney disease.
** No aspirin, β-blockers, or ACE-inhibitors at hospital discharge.

Danchin, et al.'s (2005) review of nationwide French cardiac registry data evidences the increased survival of patients receiving triple therapy, combination of anti-platelet agents, β-blockers, and statins. The one-year survival was 97% in patients that received triple therapy and 88% in those who did not ($p<.0001$). Of note, in all quartiles, combination therapy was associated with lower mortality. As with the renal compromised patients, the group with the highest risk score and highest mortality also gained the most from triple therapy. However, this group was the least likely to receive triple therapy. The benefit of triple therapy was evidenced in ST-elevation myocardial infarction and non-ST-elevation myocardial infarction patients.

The Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications (CADILLAC) trial found a significantly higher 30-day mortality rate, post-hospital discharge, who did not receive aspirin therapy (6.2% vs. 0.3%, $p$ <0.0002) (Kandarzi, 2004). Patients who did not receive a prescription for aspirin at discharge still had a higher mortality rate at one year (12.4% vs. 2.3%, $p$ <0.0001) and consequently, saw as a result, a significant increase in composite occurrence of major adverse cardiac events take place. Moreover, those patients that did not receive aspirin at discharge had a greater need for repeat targeted vessel revascularization. Kardanzi, et al. (2004) note "our [CADILLAC] results support this paradoxic quality of care for patients who have AMI and are at greater risk; despite the protocol-specified administration of aspirin, greater baseline clinical risk, and less procedural success among patients who did not receive aspirin at discharge, 67 patients did not receive such treatment." (p. 1033).

While studies have illustrated increases in usage of combination therapy, there were still areas in need of improvement (Spencer et al., 2005). Spencer et al. (2005) studied a sample of 5965 adult men and women of all ages discharged after AMI from all greater Worcester hospitals between 1990 and 2001. The study reviewed the usage of angiotensin-converting enzyme (ACE) inhibitors, aspirin, β-blockers, and lipid-lowering agents, cardiac medications with proven efficacy in managing AMI patients and found an increase from 12.9% to 74.0% of hospital survivors who received three or more cardiac medications, but more work is needed. A Swiss study of nearly 12,000 patients with acute coronary syndrome (ACS) found increased underutilization of combination cardioprotective therapy even after accounting for contraindications and controlling for comorbidities (Schoenenberger, Radovanovic, Stauffer, Windecker, Urban, Eberli, et al. 2008).

Yusuf (2002) has suggested that two-thirds to three-quarters of future vascular events could be prevented through the effective usage of combination cardioprotective therapy for high risk patients.

*Age differences*

Even after recommendations from The American College of Cardiology (ACC) and the American Heart Association (AHA), studies in multiple countries have indicated a difference in implementation of guideline-recommended AMI therapies between younger and older patients. In 2004, a Canadian study utilizing the Canadian Cardiovascular Research Team (CCORT)/Canadian Cardiovascular Society (CCS) Quality Indicators for AMI Care, found that the odds ratio of ideal (no contraindications) 65 year old or older patients receiving evidence-based AMI therapies was less than half of 65 year old or younger patients with AMI, except ACEIs at discharge, suggesting less than optimal implementation (Tran et al., 2004). The difference was most pronounced in the oldest patients. Adjustments for common contraindications, as per practice guidelines and applicable literature, did not alter this finding. Figure 1 details the comparison of the percentage of ideal patients, those without common contraindications or exclusion criteria, to the benchmark values.

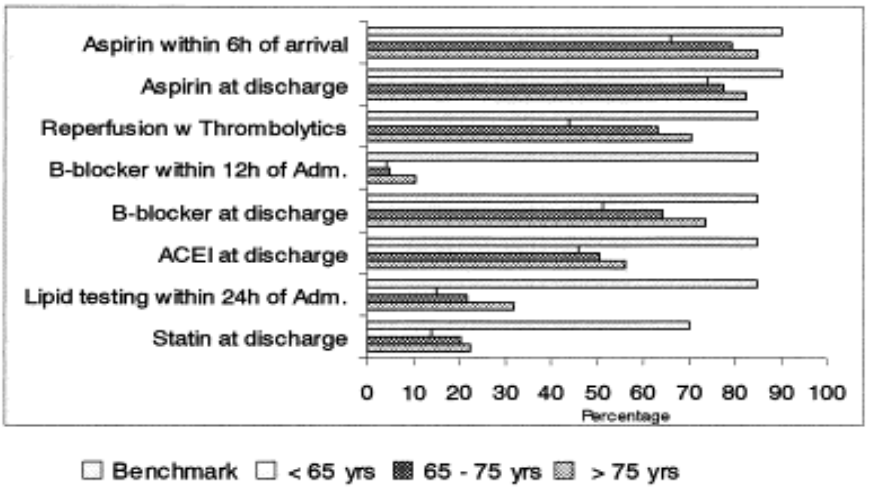



Figure 1. Comparison of proportion of ideal patients who received treatment relative to benchmark values.

*Benchmark values are defined as 90% or greater of ideal patients receiving aspirin within six hours of arrival and aspirin at discharge. The benchmark values are 85% or more of ideal patients receiving thrombolytics within or less than 30 minutes of arrival, ideal patients receiving β-blocker within 12 hours of admission, ideal patients receiving β-blocker at discharge, ideal patients being prescribed an ACEI at discharge, and ideal patients having a lipid sample obtained within 24 hours of admission. The benchmark value is 70% or more of ideal patients having a statin prescribed at hospital discharge.

---

From "Effect of age on the use of evidence-based therapies for acute myocardial infarction," by C.T.T. Tran, A. Laupacis, M.M. Mamdani, and J.C. Tu, 2004, *American Heart Journal,148(5),* p.838.

Kardanzi (2004) emphasizes that risks or concerns about contraindications do not seem to factor into treatment practice as similar proportions of eligible and ideal elderly patients receive medications. Some physicians appear to be unaware of the medical evidence available detailing the benefit of aspirin, β-blockers, thrombolytics, ACEIs, lipid measurements, and statin treatment in the elderly population. They hypothesize that while physicians may have knowledge of the reported therapeutics benefits they do not believe there is an actual benefit on patient outcomes. Moreover, perhaps concerns over poly-pharmacy are greater than the perceived benefits for the elderly patient should he receive all for treatments for which he was eligible.

*Gender Differences*

Significant differences in adherence to acute myocardial infarction guidelines have been found by gender. Spencer (2005) found the female sex to be independently associated with the

underuse of combination medical therapy. While the study was limited by the lack of ability to determine eligibility for treatments, the association is of note. Correa-de-Araujo, et al. (2006) found significant differences between non-Hispanic white males and females in aspirin upon arrival, aspirin at discharge, β-blocker at arrival and β-blocker at discharge. Significant differences, between the same groups, were also found in treatment administration for AMI patients with diabetes and those AMI patients with hypertension/ESRD. These significant differences were not found between genders of other races or ethnicities. Correa-de-Araujo, et al.'s (2006) study excluded those patients that were not eligible to receive treatment, expanding on Spencer's (2005) findings.

*Costs*

Figures on the overall hospital costs for the long term treatment of acute myocardial infarction patients in the United States is very limited. Furthermore, comparing costs amongst groups within the AMI population are further limited by differing reimbursement systems and the complexity and confidentiality of contracts between insurers and hospitals. Eisenstein, et al. (2001) attempted to calculate, through models not actual costs incurred, long term economic outcomes for coronary artery disease [of which acute myocardial infarction is included]. They found that while the total acute costs for unstable angina (NSTEMI) patients was less than for STEMI patients ($21,957 vs. $24,956) the post acute costs for unstable angina were greater than those for STEMI patients ($27,787 vs. $22,421) (Eisenstein et al., 2001).

*Indicators for Cost*

Several studies have shown length of stay in hospitals to be highly correlated with total hospital costs (Kauf, Velasquez, Crosslin, Weaver, Diaz, et al., 2006; Krumholz, Chen, Murillo, Cohen, and Radford, M., 1998; Mahon, McCann, Rahallaigh, Codd and O'Sullivan, 2008). In

addition to length of stay, Brampkamp, et al., (2007) found the strongest predictors of higher AMI hospital costs to be gender, cerebrovascular disease and diabetes. Polverejan, et al. (2003) found cardiac procedures, ejection fraction, and age at admission to be significant predictors of higher costs. Studies differ in finding higher AMI treatment costs for men and women (Brampkamp, et.al, 2007; Polverejan, Gardiner, Bradley, Holmes-Rovner, & Rovner, 2003). Furthermore, advanced age has been found to be associated with lower costs. Udvarhelyi & Gatsonis, (1992), found that older patients are less eligible for various cardiac treatments.

*Costs and quality measures*

Minimal studies have examined the difference in hospital costs amongst patients that received acute myocardial infarction evidence-based guidelines. Krumholz, et al. did find that those that received evidence-based guidelines (i.e. thrombolysis, aspirin, and β-blockers) were significantly more costly than those that did not receive such measures (1998). Those patients were also found to have lower in-patient mortality and were referred for more cardiac procedures (Krumholz, et al., 1998).

This retrospective study seeks to further understanding of actual hospital costs and the perfect compliance with the acute myocardial infarction evidenced-based care bundle.

# Chapter 3: Methodology

The purpose of this study was to identify if there was a difference in hospital costs between those acute myocardial infarction patients that received 100% of eligible core measures, a "perfect score", and those that did not receive 100% of eligible core measures.

A quantitative study was conducted through the utilization of retrospective, secondary data on 440 acute myocardial infarction patients that were treated at a community-based hospital in the Western United States.

## *Sampling Strategy*

The participants in the study included those as defined by the Centers for Medicare and Medicaid Services Acute Myocardial Infarction Core Measure algorithm (Appendix A and B). The participants in the study included those acute myocardial infarction patients over 18 years of age, on date of admission, that were randomly sampled by the organization's Core Measure reporting vendor, Premier. Premier collects data from member hospitals throughout the country and "houses the nation's largest detailed clinical and financial database, housing information on more than 130 million patient discharges."(Premier, n.d.). Premier randomly selects 10% of patients discharged with (ICD-9-CM 410.x principal diagnosis code) up to a maximum of 26 patients per month. Given the hospital's large AMI population, 26 AMI patient charts were abstracted per month. If it was discovered that a patient is to receive comfort care only, another randomly sampled AMI patient was requested by the data collector and supplied by Premier for abstraction. Trained data collectors within the healthcare system used standardized definitions to abstract the data. Variables included demographics, treatments administered, associated major contraindications to evidence-based therapies, discharge recommendations, and interventions. These patients were discharged from the hospital from August 1, 2006 to December 31, 2007.

The sample included male and female patients with an *International Classification of Diseases-CM-9* Principal Diagnosis Code of AMI, (410.x.x) (International Classification of Diseases, 2003). As defined by CMS, the population for the measure set only included patients admitted to the hospital for inpatient acute care. Furthermore, the patients came directly to the hospital, that is, not transferred from another facility or transferred out to another facility. It included those patients transported by ambulance or walk-ins.

*Exclusion criteria*

Those patients that were not eligible for any of the core measures were removed from the sample. Those patients that were transferred to another acute care facility or federal hospital were removed because it was unclear if the patient received additional core measures and mortality was not determined. Patients discharged to hospice and patients with comfort care measures only as documented by a physician, nurse practitioner, or physician assistant were also excluded from the population. Patients that were treated outside of an inpatient environment were also excluded from this population as defined by the Centers for Medicare and Medicaid Services core measure eligibility. After implementing the exclusion criteria the sample population included 382 acute myocardial infarction patients.

*Participation*

There were 382 acute myocardial infarction patients in the study. Of these, 304 patients did not have ST-segment elevation or left bundle branch block (LBBB). ST-segment elevation or left bundle branch block (LBBB) is defined from the initial ECG interpretation performed closest to hospital arrival. ST-segment elevation or a left bundle branch block (LBBB) (as defined by Hospital Quality Measures Specification Manual) is outlined.

The normal ECG is composed of a P wave (atrial depolarization), Q, R, and S waves (QRS complex, ventricular depolarization), and a T wave (ventricular repolarization). The ST-segment, the segment between the QRS complex and the T wave, may be elevated when myocardial injury (AMI) occurs. Between the atria and the ventricles, the conduction system divides electrical impulses into right and left bundle branches. A bundle branch block (BBB) results from impaired conduction in one branch, which in turn results in abnormal ventricular depolarization. In LBBB, left ventricular depolarization is delayed, resulting in a characteristic widening of the QRS complex on the ECG. LBBB may be an electrocardiographic manifestation of an AMI (CMS, 2006).

Patients were placed in these categories as STEMI or left bundle branch block (LBBB) are eligible for percutaneous coronary intervention and those with NSTEMI or left bundle branch block were not eligible for percutaneous coronary intervention. Patients were separated into two race categories: Caucasian, and non-Caucasian due to minimal population diversity in the region. Length of stay was categorized based upon average length of stay for acute myocardial infarction (principal diagnosis 410.x.x.) of over 450 hospitals in the United States (Premier, 2008). Length of stay is defined as the time period the patient has been in the hospital for their inpatient stay. A day for an inpatient is based on the patient being in the hospital at midnight. The population was separated into five age categories: less than 50 years old, 50 years old and less than 60 years old, 60 years old and less than 70 years old, 70 years old and less than 80 years old, and greater than 80 years old. These age categories were determined by assessing the age of the nationwide AMI population and separating it into manageable time periods.

Inpatient mortality was divided into two categories: alive at discharge or expired during hospital stay. This is the inpatient mortality description for set measure id number: AMI-9 (CMS,

2008). The Perfect score population was divided into groups: acute myocardial infarction patients that received 100% of eligible core measures, “perfect score” and those that did not receive 100% of eligible core measures. The “perfect score”, also known as the "appropriate care score", is a measure of the number of times patients received all the care for which they were eligible. Eligible for denotes no contraindications.

The population was divided into two gender groups: female and male. The population was separated by APR-DRG severity groups (1, 2, 3, and 4) to account for some of the co-morbidities which may influence costs. APR-DRG Severity Grouper Methodology as defined in the Premier database:

> Patients in Clinical Advisor are grouped with 3M™’s APR-DRG grouper. APR-DRGs™ integrate the Medicare DRGs, New York AP-DRGs, NACHRI DRGs and Yale Complication and Comorbidity Refinements into a comprehensive DRG system. They attempt to explain most severity of illness within the severity of illness levels of the base DRGs. The APR-DRG grouper categorizes patients into similar disease categories and then stratifies them into four subclasses for severity of illness and four subclasses for risk of mortality. There are 316 base APR-DRGs in version 20.0. The subdivision of each of the 316 APR-DRGs into four severity of illness subclasses, combined with two error APR-DRGs (955, 956), which are not subdivided, results in 1,258 APR-DRGs. Severity of illness-adjusted data focuses on explaining differences in length of stay, resource utilization or costs by adjusting for the interaction of diagnoses, procedures, and age. Resource use and outcomes are similar for patients in each severity of illness level, providing more accurate comparisons. Patients fall into a base APR-DRG according to the following variables: • Age • Procedure • Principal Diagnosis. They are further

> classified into one of four severity of illness levels based on the following variables: • Base APR-DRG • Age • Non-operating room procedures • Additional diagnosis • Combinations of all the above. (Premier, Inc., 2008, p. 137, 2-3)

*Instrumentation*

There was no formal instrumentation to be used since the data was collected as retrospective, secondary data, which was derived from two pre-existing electronic applications, Premier and Trendstar®. Trendstar® was an electronic decision support solution from McKesson Corporation (Healthcare Management Insight, n.d.). Trendstar® housed the hospital's financial information. Premier's Quality Measures Reporter solution tracks performance compared to national benchmarks such as Centers for Medicaid and Medicare Services Scope of Work, The Joint Commission, Leapfrog, other hospitals submitting data to Premier, etc. It minimizes complexity of abstraction and enables one to immediately correct abstraction errors. The Premier database and Trendstar® solution were selected over ad hoc reports from existing clinical applications (ex. MEDITECH and Epic) for economy of time and more extensive ability to mine the data.

The data used for this research project was from the Premier database and the Trendstar® database. Approval was granted from the Directors of Quality Decision Support and Financial Decision Support. As the data included Patient ID (visit number) information, an identifying factor under HIPAA, approval was sought from the hospital Institutional Review Board and Regis University Institutional Review Board prior to collecting the data. The data was from 17 month period (August 1, 2006-December 31, 2007). Approval was received from the hospital Institutional Review Board on October 13, 2008. Approval was received from the University Review Board on November 1, 2008.

The hospital in the study was a non-teaching, trauma-designated, community-based facility located in the Western United States. The hospital had open heart and cardiac catheterization capabilities. Eighty-six percent of U.S. hospitals are community-based making the usage of hospital data more generalizeable. The number of discharges for this group, community-based hospitals, is increasing an average of 1.5% per year (Levit et al., 2007).

*Data Collection*

Administrative data reports and financial data reports were run out of Premier and Trendstar®, respectively. The two reports were combined in an Excel document utilizing the patient ID (visit number) as a unique identifier. The reports did not include names, medical record numbers or addresses to minimize the Protected Health Information. The administrative reports were run by a member of the organization's Quality Decision Support team. Permission for running said report was received from the director of the department. This data was transmitted over a secure intranet and stored on a secure network location with access given only to members of the Quality Improvement team. The financial reports were run by a member of the organization's Financial Decision Support team. Permission for running said report was received from the director of the department. This data was transmitted over a secure intranet and stored on a secure network location with access given only to members of the Quality Improvement and Financial Decision Support team. Patient identifier information was minimal with names, medical record numbers and addresses removed; therefore an individual had to have access (password protected) to the clinical database to learn additional information. Names and addresses were not included in the administrative database. Furthermore, an individual had to have access (password protected and tracked) to the financial database to learn additional patient

identifier information. The patient identifier information was not revealed in the analysis and therefore, unavailable to providers or others who may influence future care for an individual.

*Statistical Analysis*

The independent variable in the study was the receipt of 100% of eligible core measures "perfect score". The measures were 100% or not 100%. The dependent variables in the study were hospital costs: total hospital costs, variable costs, fixed costs, direct costs and indirect costs. An alpha level of 0.05 was used on all statistical tests. Descriptive statistics were run on the data to provide information. Potential influencing variables were tested to identify whether or not there was a significant difference in total costs, variable costs, fixed costs, direct costs and indirect costs between the different levels for each variable.

Independent sample t-tests were completed to assess if there was a significant difference in total hospital costs, variable costs, fixed costs, direct costs, indirect costs between STEMI and NSTEMI patients.

If there was a very minimal non-Caucasian sample size no statistical tests would be completed to assess if there was a significant difference in total hospital costs, variable costs, fixed costs, direct costs, and indirect costs between Caucasian and non-Caucasian patients.

Independent sample t-tests were completed to assess if there was significant difference in total hospital cost, variable costs, fixed costs, direct costs, and indirect costs between males and females. If there was a significant difference, then gender was identified as a covariate. ANCOVA would be run to normalize the effect of the covariate if gender was identified as a covariate.

Independent sample t-tests were completed to assess if there was significant difference in total hospital cost, variable costs, fixed costs, direct costs, and average indirect costs between

length of stay five days or less and length of stay greater than five days. If there was a significant difference and length of stay was identified as a covariate. A Pearson correlation test would be completed to assess if there was a relationship between length of stay and total hospital cost, variable costs, fixed costs, direct costs, and indirect costs.

ANOVA was completed to assess if there is a significant difference in hospital costs, variable costs, fixed costs, direct costs, and indirect costs between age groups (less than 50 years old, 60-70 years old, 70-80 years old, 80 years and older). If a significant difference was found between the age groups and total hospital cost, average variable costs, fixed costs, direct costs, and indirect costs age was identified as a covariate. If age was identified as a covariate ANOVA Scheffe post-hoc test would be completed to determine between which age groups there was a significant difference. If differences were found between a few groups interval data would be used to assess if there was a relationship between age and costs on a continual basis using Pearson correlation.

Independent samples t-test was completed to assess if there was a significant difference between total hospital costs, variable costs, fixed costs, direct costs, and indirect costs and inpatient mortality. If there was significant difference between total hospital costs, variable costs, fixed costs, direct costs, and indirect costs and inpatient mortality, inpatient mortality would be identified as a covariate. ANCOVA would be run to normalize the effect of the covariate if inpatient mortality was identified as a covariate.

ANOVA was completed to assess if there is a significant difference between total hospital costs, variable costs, fixed costs, average direct costs, and indirect costs and APR-DRG severity levels (1, 2, 3, and 4). If there was a significant difference and APR-DRG severity

would be identified as a covariate. If APR-DRG severity was identified as a covariate ANOVA Post hoc Scheffe test would be run to determine the difference between groups.

Independent sample t-tests were completed to assess if there was a significant difference between total hospital costs, variable costs, fixed costs, direct costs, and indirect costs and those patients that received 100% of eligible core measures, "perfect score" and those that did not.

The methodology and statistical analysis conducted sought to answer the null hypothesis: there was no difference in hospital costs for those acute myocardial infarction patients that receive 100% of eligible core measures and those that do not receive 100% of eligible core measures.

# Chapter 4: Results

The purpose of this study was to evaluate whether there was a significant difference in hospital costs between those acute myocardial infarction patients that received 100% of eligible core measures, "perfect score", and those that did not. There were a total of 382 acute myocardial infarction patients in the study sample size. Seven potential covariates were analyzed in this study prior to the assessment of the "perfect score".

## *Descriptive Statistics*

The descriptive statistics for those seven potential covariates are shown in Tables 3, 4, 5, 6, 7, 8, 9 and 10.

Table 3

*Number of AMI patients treated at facility per STEMI or NSTEMI status*

| Type | *n* | Percent |
|---|---|---|
| STEMI | 78 | 20.4 |
| NSTEMI | 304 | 79.6 |
| Total Patients | 382 | 100 |

Table 4

*Number of AMI patients treated at the facility per Race*

| Race | *n* | Percent |
|---|---|---|
| Caucasian | 370 | 96.9 |
| Non-Caucasian | 4 | 1.0 |
| Undetermined Race | 8 | 2.1 |
| Total Patients | 382 | 100 |

Table 5

*Number of AMI Patients treated at the facility by Gender*

| Gender | *n* | Percent |
|---|---|---|
| Female | 150 | 39.3 |
| Male | 232 | 60.7 |
| Total Patients | 382 | 100 |

Table 6

*Number of AMI patients treated at the facility by Length of Stay (LOS)*

| Length of Stay | *n* | Percent |
|---|---|---|
| 5 days of less | 317 | 83.0 |
| Greater than 5 days | 65 | 17.0 |
| Total Patients | 382 | 100 |

*Length of Stay*

The majority, 83.0% of AMI patients had a length of stay five days or less. The mean length of stay was 3.96 days with a standard deviation of 4.15 days.

Table 7

*Number of AMI patients treated at the facility by Age*

| Age | *n* | Percent |
|---|---|---|
| <50 | 44 | 11.5 |
| 50 to <60 | 78 | 20.4 |
| 60 to <70 | 91 | 23.8 |
| 70 to <80 | 80 | 20.9 |
| ≥ 80 | 89 | 23.3 |
| Total Patients | 382 | 100 |

*Age*

The mean age of patients at discharge was 67.41 years old with a standard deviation of 14.29 years.

Table 8

*Number of AMI patients treated at the facility per discharge status*

| Discharge Status | *n* | Percent |
|---|---|---|
| Alive | 378 | 99.0 |
| Dead | 4 | 1.0 |
| Total Patients | 382 | 100 |

*Mortality*

The overwhelming number of patients in the sample survived the hospital stay, 99.0%. Only 1.0% died during the inpatient stay.

Table 9

*Number of AMI patients treated at the facility per APR-DRG severity*

| APR-DRG Severity | *n* | Percent |
|---|---|---|
| APR-DRG Severity-1 | 115 | 30.1 |
| APR-DRG Severity-2 | 161 | 42.1 |
| APR-DRG Severity-3 | 80 | 20.9 |
| APR-DRG Severity-4 | 26 | 6.8 |
| Total Patients | 382 | 100 |

Table 10

*Number of AMI treated at facility per "Perfect Score" status*

| Perfect Score Status | *n* | Percent |
|---|---|---|
| <100% eligible core measures | 36 | 9.4 |
| 100% eligible core measures | 346 | 90.6 |
| Total Patients | 382 | 100 |

*Perfect Score*

Of those that did not receive 100% of eligible core measures, 8 (22.2%) were female and 28 (77.78%) were male. Of those that did receive 100% of eligible core measures, 142 (41.0%) were female and 204 (59.0%) were male. Ninety-four and seven tenths percent of females in the

sample and 87.9% of men in the sample received 100% of eligible core measures. The average length of stay for those patients that did not receive 100% of eligible core measures was 4.17 days. The average length of stay for those patients that received 100% of eligible core measures was 3.93 days.

Table 11

*Hospital Costs for AMI patients by cost type*

| Hospital Cost | Range | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|---|
| Total Costs | 116,719.31 | 1,596.10 | 118,315.41 | 15,839.23 | 13,494.53 |
| Variable Costs | 72,350.60 | 608.54 | 72,959.14 | 7,362.47 | 6,924.36 |
| Fixed Costs | 51,770.91 | 987.56 | 52,758.47 | 8476.76 | 6,896.83 |
| Direct Costs | 89,849.12 | 959.70 | 90,808.82 | 10,843.33 | 9,362.63 |
| Indirect Costs | 28,937.96 | 636.40 | 29,574.36 | 4,995.90 | 4,333.12 |

*Statistical Analysis*

An alpha level of 0.05 was used for all statistical tests.

*ST-elevated (STEMI) and Non-ST-elevated (NSTEMI)*

An independent samples t-test was completed to compare total hospital cost, variable costs, fixed costs, direct costs, and indirect costs between STEMI and NSTEMI patients. Table 12 shows there was no statistically significant difference between total hospital costs, variable costs, fixed costs, direct costs, or indirect costs between STEMI and NSTEMI patients.

Table 12

*Difference between STEMI and NSTEMI t-tests*

| | *t* | *p* | 95% Confidence interval of the mean difference |
|---|---|---|---|
| Total Costs | .850 | .396 | (-1414.70, 3558.52) |
| Variable costs | .548 | .584 | (-914.55, 1619.65) |
| Fixed costs | 1.091 | .277 | (-581.12, 2019.85) |
| Direct costs | .540 | .590 | (-1235.45, 2167.46) |
| Indirect costs | 1.440 | .151 | (-223.88,1435.68) |

*Race*

There was a very minimal non-Caucasian sample size, 4, and as a result, no statistical tests were completed to assess if there was a significant difference in total hospital costs, variable costs, fixed costs, direct costs, and indirect costs between Caucasian and non-Caucasian patients.

*Gender*

An independent sample t-test was completed to determine if there was a difference in total hospital costs between male and female patients. Male patients had significantly higher total hospital costs than female patients, $t(370.37) = 3.92$, $p < .001$. An independent sample t-test was completed to determine if there was a difference in variable costs between male and female patients. Male patients had significantly higher variable costs than female patients, $t(376.17) = 4.03$, $p = <.001$. An independent sample t-test was completed to determine if there was a difference in fixed costs between male and female patients. There was a significant difference in fixed costs between male and female patients, $t(364.74) = 3.64$, $p < .001$. An independent sample t-test was completed to determine if there was a difference in direct costs between male

and female patients. There was a significant difference in direct costs between male and female patients, $t(370.58) = 4.01$, $p < .001$. An independent sample t-test was completed to determine if there was a difference in indirect costs between male and female patients. There was a significant difference in indirect costs between male and female patients, $t(372.10) = 3.56$, $p < .001$.

Table 13

*Difference between gender t tests*

| | *t* | *p* | 95% Confidence Interval of the mean difference |
|---|---|---|---|
| Total cost | 3.921 | <0.001 | 2565.56, 7726.86 |
| Variable cost | 4.029 | <0.001 | 1372.46, 3988.45 |
| Fixed cost | 3.637 | <0.001 | 1132.52, 3798.99 |
| Direct cost | 4.010 | <0.001 | 1858.71, 5435.60 |
| Indirect cost | 3.557 | <0.001 | 670.30, 2327.81 |

An independent samples t-test was completed to compare length of stay between male and female patients. There is no statistically significant difference in length of stay between male and female patients, $t(380) = 1.12$, $p = 0.263$. A Chi square test was completed to determine if there was an association between APR-DRG severity levels and gender. An association was found between APR-DRG severity level and gender, $\chi^2 (1) = 5.24$, $p = 0.022$. APR-DRG severity-1: A greater percentage of men were in APR-DRG severity-1 (36.6%) than women (20.0%). APR-DRG severity-2: A greater percentage of women (48.7%) were in APR-DRG severity-2 than men (37.9%). APR-DRG severity-3: A greater percentage of women (25.3%) than men (18.1%) were in APR-DRG severity-3. APR-DRG severity-4: Percentages of men (7.3%) and women (6.0%) were very similar in APR-DRG severity 4.

*Length of Stay*

An independent samples t-test was completed to compare total hospital costs between patients with length of stay five days or less and length of stay greater than five days. There was a statistically significant difference between total hospital costs for patients with length of stay five days or less and those with a length of stay greater than five days, $t(65.49) = -8.90$, $p < .001$. An independent samples t-test was completed to compare variable costs between patients with length of stay five days or less and length of stay greater than five days. There was a statistically significant difference between variable costs for patients with length of stay five days or less and those with a length of stay greater than five days, $t(66.23) = -7.77$, $p < .001$. An independent samples t-test was completed to compare fixed costs between patients with length of stay five days or less and length of stay greater than five days. There was a statistically significant difference between fixed costs for patients with length of stay five days or less and those with a length of stay greater than five days, $t(65.09) = -9.61$, $p < .001$. An independent samples t-test was completed to compare direct costs between patients with length of stay five days or less and length of stay greater than five days. There was a statistically significant difference between direct costs for patients with length of stay five days or less and those with a length of stay greater than five days, $t(65.86) = -8.18$, $p < .001$. An independent samples t-test was completed to compare indirect costs between patients with length of stay five days or less and length of stay greater than five days. There was a statistically significant difference between indirect costs for patients with length of stay five days or less and those with a length of stay greater than five days, $t(65.01) = -10.10$, $p < .001$. Those patients that had lengths of stay greater than five days had significantly higher costs (total hospital costs, variable, fixed, indirect and direct) than those patients that had lengths of stay five days or less. Length of stay was identified as a covariate.

Table 14

*Differences between lengths of stay t tests*

| | *t* | *p* | 95% Confidence interval of the mean difference |
|---|---|---|---|
| Total cost | -8.901 | <0.001 | -29402.57, -18627 |
| Variable cost | -7.77 | <0.001 | -13879.70, -8206.91 |
| Fixed cost | -9.61 | <0.001 | -15667.44, -10275.91 |
| Direct cost | -8.18 | <0.001 | -19459.47, -11822.75 |
| Indirect cost | -10.10 | <0.001 | -10029.32, -6718.41 |

A Pearson correlation test was completed to assess if there was a relationship between length of stay and total hospital costs. A strong significant relationship was found between length of stay and total hospital costs, $r = 0.84$, $p < .001$. A Pearson correlation test was completed to assess if there was a relationship between length of stay and variable costs. A strong significant relationship was found between length of stay and variable costs, $r = 0.76$, $p < .001$. A Pearson correlation test was completed to assess if there was a relationship between length of stay and fixed costs. A strong significant relationship was found between length of stay and fixed costs, $r = 0.88$, $p < .001$. A Pearson correlation test was completed to assess if there was a relationship between length of stay and direct costs. A strong significant relationship was found between length of stay and direct costs, $r = 0.81$, $p < .001$. A Pearson correlation test was completed to assess if there was a relationship between length of stay and indirect costs. A strong significant relationship was found between length of stay and indirect costs, $r = 0.87$, $p < .001$.

*Age*

ANOVA was completed to assess if there was a significant difference in total hospital costs between age groups (less than 50 years old, 50 years old to less than 60 years old, 60 years old to less than 70 years old, 70 years old to less than 80 years old, and 80 years old and older). A significant difference was found in total hospital costs between age groups, $F$ (4,381) = 3.99, $p$ = 0.003. ANOVA was completed to assess if there was a significant difference in variable costs between age groups (less than 50 years old, 50 years old to less than 60 years old, 60 years old to less than 70 years old, 70 years old to less than 80 years old, and 80 years old and older). A significant difference was found in variable costs between age groups, $F$ (4,381) = 3.26, $p$ = 0.012. ANOVA was completed to assess if there was a significant difference in fixed costs between age groups (less than 50 years old, 50 years old to less than 60 years old, 60 years old to less than 70 years old, 70 years old to less than 80 years old, and 80 years old and older). A significant difference was found in fixed costs between age groups, $F$ (4,381) = 4.53, $p$ = 0.001. ANOVA was completed to assess if there was a significant difference in direct costs between age groups (less than 50 years old, 50 years old to less than 60 years old, 60 years old to less than 70 years old, 70 years old to less than 80 years old, and 80 years old and older). A significant difference was found in direct costs between age groups, $F$ (4,381) = 3.85, $p$ = 0.004. ANOVA was completed to assess if there was a significant difference in indirect costs between age groups (less than 50 years old, 50 years old to less than 60 years old, 60 years old to less than 70 years old, 70 years old to less than 80 years old, and 80 years old and older). A significant difference was found in indirect costs between age groups, $F$ (4,381) = 4.12, $p$ = 0.003. Age was identified as a covariate.

An ANOVA Scheffe post-hoc test was completed to determine between which age groups there was a significant difference in total hospital costs. There was a significant difference in total costs between 60 year old to less than70 age group and the 80 year old or older age group, $\alpha = 0.011$, (1082.57, 13346.41), with the former group having higher total costs. No significant differences in total costs were found between the other groups. An ANOVA Scheffe post-hoc test was completed to determine between which age groups there was a significant difference in variable costs. There was a significant difference in variable costs between 60 year old to less than70 age group and the 80 year old or older age group, $\alpha = 0.031$, (192.03, 6508.41), with the former group having higher costs. No significant differences in variable costs were found between the other groups. An ANOVA Scheffe post-hoc test was completed to determine between which age groups there was a significant difference in fixed costs. There was a significant difference in fixed costs between 60 year old to less than70 age group and the 80 year old or older age group, $\alpha = 0.006$, (738.78, 6989.77), with the former group having higher costs. No significant differences in fixed costs were found between the other groups. An ANOVA Scheffe post-hoc test was completed to determine between which age groups there was a significant difference in direct costs. There was a significant difference in direct costs between 60 year old to less than70 age group and the 80 year old or older age group, $\alpha = 0.012$, (706.31, 9221.18), with the former group having higher costs. No significant differences in direct costs were found between the other groups. An ANOVA Scheffe post-hoc test was completed to determine between which age groups there was a significant difference in indirect costs. There was a significant difference in indirect costs between 60 year old to less than70 age group and the 80 year old or older age group, $\alpha = 0.015$, (283.10, 4218.39), with the former group having higher costs. No significant differences in indirect costs were found between the other groups.

Because there was only a difference between two of the five groups interval data was used in a Pearson correlation to assess if there was a relationship between age and total cost on a continual basis. No significant relationship was found between age and total costs, $r = -0.04$, $p = 0.442$. A Pearson correlation was completed to assess if there was a relationship between age and variable cost on a continual basis. No significant relationship was found between age and variable costs, $r = -0.04$, $p = 0.454$. A Pearson correlation was completed to assess if there was a relationship between age and fixed cost on a continual basis. No significant relationship was found between age and fixed costs, $r = -0.04$, $p = 0.452$. A Pearson correlation was completed to assess if there was a relationship between age and direct cost on a continual basis. No significant relationship was found between age and direct costs, $r = -0.044$, $p = 0.393$. A Pearson correlation was completed to assess if there was a relationship between age and indirect cost on a continual basis. No significant relationship was found between age and indirect costs, $r = -0.03$, $p = 0.583$.

*Mortality*

An independent sample t-test was completed to determine if there was a difference in total hospital costs, variable costs, fixed costs, direct costs, and indirect costs between patients alive at discharge and those that died during the inpatient stay. As illustrated in Table 15, there was no significant difference between total hospital costs, variable costs, fixed costs, direct costs, or indirect costs between those that died during the inpatient stay.

Table 15

*Differences between mortality (discharge status) t tests*

| | *t* | *p* | 95% Confidence interval for difference of means |
|---|---|---|---|
| Total cost | .488 | .626 | -10033.70, 16666.32 |
| Variable cost | .380 | .704 | -5526.15, 8175.94 |
| Fixed cost | .574 | .566 | -4830.74, 8813.56 |
| Direct cost | .409 | .683 | -7336.34, 11190.10 |
| Indirect cost | .637 | .524 | -2896.34, 5675.19 |

*APR-DRG Severity*

ANOVA was completed to assess if there was a significant difference in total hospital costs between APR-DRG severity categories. A significant difference was found in total hospital costs between APR-DRG severity categories, $F$ (3,381) = 27.68, $p < .001$. ANOVA was completed to assess if there was a significant difference in variable costs between APR-DRG severity categories. A significant difference was found in variable costs between APR-DRG severity categories, $F$ (3,381) = 22.47, $p < .001$. ANOVA was completed to assess if there was a significant difference in fixed costs between APR-DRG severity categories. A significant difference was found in fixed costs between APR-DRG severity categories, $F$ (3,381) = 30.71,$p < .001$. ANOVA was completed to assess if there was a significant difference in direct costs between APR-DRG severity categories. A significant difference was found in direct costs between APR-DRG severity categories, $F$ (3,381) = 26.30, $p < .001$. ANOVA was completed to assess if there was a significant difference in indirect costs between APR-DRG severity

categories. A significant difference was found in indirect costs between APR-DRG severity categories, $F$ (3,381) = 28.71, $p < .001$.

An ANOVA Scheffe post-hoc test was completed to determine between which APR-DRG severity groups there was a significant difference in total hospital costs. There was a significant difference in total hospital costs between APR-DRG severity levels. APR-DRG severity-1 total hospital costs were significantly lower than APR-DRG severity-3 total hospital costs, α = 0.005, (-11491.51,-1461.09) and significantly lower than APR-DRG severity-4 total hospital costs, α = 0.000, (-30207.34, -15246.02). APR-DRG severity-2 total hospital costs were significantly lower than APR-DRG severity-3 total hospital costs, α = 0.025, (-9873.70, -449.46) and significantly lower than APR-DRG severity-4 total hospital costs, α = 0.000, (-28692, -14131.03). APR-DRG severity-3 total hospital costs were significantly lower than APR-DRG severity-4 total hospital costs, α = 0.000, (-24026.94, -8476.83).

An ANOVA Scheffe post-hoc test was completed to determine between which APR-DRG severity groups there was a significant difference in variable costs. There was a significant difference in variable costs between some APR-DRG severity levels. APR-DRG severity-1 variable costs were significantly lower than APR-DRG severity-4 variable costs, α = 0.000, (-14262.97, -6816.38). APR-DRG severity-2 variable costs were significantly lower than APR-DRG severity-4 variable costs, α = 0.000, (-14228.78,-6626.72). APR-DRG severity-3 variable costs were significantly lower than APR-DRG severity-4 variable costs, α = 0.000, (-12359.60, -4240.05).

An ANOVA Scheffe post-hoc test was completed to determine between which APR-DRG severity groups there was a significant difference in fixed costs. There was a significant difference in fixed costs between some APR-DRG severity levels. APR-DRG severity-1 fixed

costs were significantly lower than APR-DRG severity-3 fixed costs, α = 0.000, (-6592.78, -1516.12). APR-DRG severity-1 fixed costs were significantly lower than APR-DRG severity-4 fixed costs, α = 0.000, (-15791.17, -8218.85). APR-DRG severity-2 fixed costs were significantly lower than APR-DRG severity-3 fixed costs, α = 0.006, (-5418.59, -648.73). APR-DRG severity-2 fixed costs were significantly lower than APR-DRG severity-4 fixed costs, α = 0.000, (-14669.29, -7299.14). APR-DRG severity-3 fixed costs were significantly lower than APR-DRG severity-4 fixed costs, α = 0.000, (-11886.48, -4014.64).

An ANOVA Scheffe post-hoc test was completed to determine between which APR-DRG severity groups there was a significant difference in direct costs. There was a significant difference in direct costs between some APR-DRG severity levels. APR-DRG severity-1 direct costs were significantly lower than APR-DRG severity-3 direct costs, α = 0.035, (-7168.14, -177.43). APR-DRG severity-1 direct costs were significantly lower than APR-DRG severity-4 direct costs, α = 0.000, (-20716.34, -10289.04). APR-DRG severity-2 direct costs were significantly lower than APR-DRG severity-4 direct costs, α = 0.000, (-20038.56, -9889.65). APR-DRG severity-3 direct costs were significantly lower than APR-DRG severity-4 direct costs, α = 0.000, (-17249.77, -6410.03).

An ANOVA Scheffe post-hoc test was completed to determine between which APR-DRG severity groups there was a significant difference in indirect costs. There was a significant difference in indirect costs between some APR-DRG severity levels. APR-DRG severity-1 indirect costs were significantly lower than APR-DRG severity-3 indirect costs, α = 0.000, (-4408.54, -1198.48). APR-DRG severity-1 indirect costs were significantly lower than APR-DRG severity-4 indirect costs, α = 0.000, (-9618.04, -4829.94). APR-DRG severity-2 indirect costs were significantly lower than APR-DRG severity-3 indirect costs, α = 0.003, (-3535.40, -

519.35). APR-DRG severity-2 indirect costs were significantly lower than APR-DRG severity-4 indirect costs, α = 0.000, (-8777.99, -4117.73). APR-DRG severity-3 indirect costs were significantly lower than APR-DRG severity-4 indirect costs, α = 0.000, (-6909.23, -1931.74). APR-DRG severity level was identified as a covariate.

*Perfect score*

An independent sample t-test was completed to determine if there were significant differences in total hospital costs, variable costs, fixed costs, direct costs and indirect costs between those patients that received 100% of eligible core measures, "perfect score" and those that did not receive 100% of eligible core measures. Table 16 shows the results of the *t*-tests, there was no significant difference in total hospital costs, variable costs, fixed costs, direct costs or indirect costs between those patients that received 100% of eligible core measures, "perfect score" and those that did not receive 100% of eligible core measures.

Table 16

*Differences between Perfect score and non-Perfect score*

| | *t* | *p* | 95% Confidence Interval of the mean difference |
|---|---|---|---|
| Total cost | .625 | .532 | -3171.03, 6129.57 |
| Variable cost | .506 | .613 | -1772.32, 3000.89 |
| Fixed cost | .716 | .475 | -1511.33, 3241.30 |
| Direct cost | .522 | .602 | -2370.64, 4083.21 |
| Indirect cost | .821 | .412 | -869.68, 2115.65 |

ANCOVA was run to normalize the effects of the covariates length of stay, gender and APR-DRG severity on hospital costs. Length of stay and gender were shown to have a

statistically significant positive effect on the perfect score's relationship with total cost. The ANCOVA results are shown in Tables 17, 18, 19, 20 and 21.

Table 17

*Total Cost ANCOVA Results*

| | *F* | *p* |
|---|---|---|
| Length of Stay | 211.097 | <0.001 |
| Gender | 18.664 | <0.001 |
| APR-DRG Severity | 3.453 | 0.064 |
| Perfect Score | 0.005 | 0.943 |

n = 382. $r^2$ = .477

Table 18

*Variable Cost ANCOVA Results*

| | *F* | *p* |
|---|---|---|
| Length of Stay | 147.37 | <0.001 |
| Gender | 16.800 | <0.001 |
| APR-DRG Severity | 1.693 | 0.194 |
| Perfect Score | 0.006 | 0.938 |

n = 382 $r^2$ =.388

Table 19

*Fixed Cost ANCOVA Results*

| | *F* | *p* |
|---|---|---|
| Length of Stay | 257.510 | <0.001 |
| Gender | 17.750 | <0.001 |
| APR-DRG Severity | 5.474 | 0.020 |
| Perfect Score | 0.056 | 0.813 |

n = 382 $r^2$ = .527

Table 20

*Direct Cost ANCOVA Results*

| | *F* | *p* |
|---|---|---|
| Length of Stay | 168.542 | <0.001 |
| Gender | 18.279 | <0.001 |
| APR-DRG Severity | 2.857 | <0.001 |
| Perfect Score | 0.004 | 0.948 |

n = 382 $r^2$ = .425

Table 21

*Indirect Cost ANCOVA Results*

| | *F* | *p* |
|---|---|---|
| Length of Stay | 293.118 | <0.001 |
| Gender | 16.604 | <0.001 |
| APR-DRG Severity | 4.481 | 0.035 |
| Perfect Score | 0.162 | 0.687 |

n = 382 $r^2$ = .552

*Interaction Effects*

There was a significant interaction effect for gender and length of stay on total costs, F = 7.71, *p* = .006. There was a significant interaction effect for gender and length of stay on variable cost, F = 6.572, *p* = .011. There was a significant interaction effect for gender and length of stay on fixed cost, F = 7.70, *p* = .006. There was a significant interaction effect for gender and length of stay on direct cost, F = 6.52, *p* = .011. There was a significant interaction effect for gender and length of stay on indirect cost, F = 9.55, *p* = .002.

The null hypothesis: there is no difference in hospital costs between those acute myocardial infarction patients that received 100% of eligible core measures and those that did not receive 100% of eligible core measures was not rejected.

# Chapter 5: Discussion

The results of the study indicated that there was no statistically significant difference in hospital costs (total hospital costs, variable, fixed, direct or indirect costs) between those patients who received 100% of eligible core measures, "perfect score" and those that did not. Adjusting for the covariates, length of stay, gender and APR-DRG severity made the results less statistically significant.

There was not a significant difference between STEMI and NSTEMI patients' hospital costs (total hospital costs, variable, fixed, direct or indirect). This finding contradicts previous studies which found STEMI was associated with increased costs (Kauf, et al., 2006; Krumholz, et al. 1998). STEMI patients had shorter lengths of stay than NSTEMI patients. This aligns with findings that procedural costs (Tiemann, 2008) are greater for STEMI than NSTEMI, however, the shorter length of stay offsets this increase in procedural cost in this study. This finding calls into question if more aggressive treatment on NSTEMI patients would lead to decreased lengths of stay and reduced hospital costs.

Contrary to previous studies (Polverejan, et al. 2003), hospital costs were not significantly different between age groups. This finding questions the literature findings that older patients do not receive as many cardiac interventions.

Chi-square confirmed an association of receipt of 100% of eligible core measures with gender, $\chi^2$ (1) = 4.83, $p$ = 0.028. A higher percentage of women, 94.7%, received 100% of eligible core measures than men, 87.9%. This finding contradicts the literature suggesting women receive less evidence-based interventions than men (Correa-de-Aruajo, et al., 2006).

Men had a significantly higher cost (total cost, variable, fixed, direct, and indirect) than women. Of note, there was no significant difference in hospital cost between men and women,

thus eliminating length of stay as the reason for the significantly higher cost. Moreover, men were found to have lower severity with 36.6% being APR-DRG severity 1 vs. 20.0% of women in APR-DRG severity 1. Women also had greater severity with 74.0% in APR-DRG severity 2 and 3 as compared to men, 56.0%. This finding indicates that it is not APR-DRG severity differences between men and women that is accounting for the difference in hospital costs.

Overall, the vast majority of the acute myocardial infarction patients received 100% of eligible core measures, "perfect score", 90.6%. In addition, very few patients in the sample died during their inpatient stay, 1.0% (n = 4).

*Significance to healthcare administration*

Many suggest that providing quality care costs more money. This study evidences that is not the case. Hospitalizations related to heart conditions comprise six of the twenty highest costing conditions for hospitals, making up 17% of all community hospital costs in 2005 (Levit et al., 2007). As a primary diagnosis, acute myocardial infarction represented 1.7% of all discharges in 2005 and was the ninth most frequent principal diagnosis for inpatient stays (Levit et al.). Acute myocardial infarction, as a principal diagnosis, ranked second in highest aggregate costs in 1997, 2004, and 2005, with total inflation-adjusted hospital costs of $8.7 billion, $11.6 billion and $10.9 billion, respectively. (Levit et al., p49).

As more quality measure data is being required to be publicly reported and more reimbursement dollars are tied to the outcomes, the actual hospital costs are of greater importance in conducting cost benefit analysis of implementing evidence-based interventions. Furthermore, this information can be a foundation on which more quality of life data can be integrated.

*Strengths*

The study had a sample size of 382 patients from a community-based facility in the Western United States. This study utilized actual hospital costs as hospital charges are not a reliable measure of resource utilization and consumption. The study reviewed seven potential covariates for their influence on hospital costs. Lastly, the study only included those measures for which individuals were eligible, a stronger indicator of quality care.

*Limitations*

The study exhibits several potential limitations. First, it is possible that unmeasured factors may have influenced hospital costs, despite accounting for multiple covariates. The sample represented patients from a single community-based facility in the Western United States. Regional differences in acute myocardial infarction treatment practices cannot be accounted for in this study. The sample population did not encompass enough non-Caucasian patients to determine if there was a significant difference in hospital costs between Caucasian and non-Caucasian patients. With only 1% of the study patients dying during their inpatient stay, the statistical analysis on inpatient mortality was incomplete. Furthermore, the high rate of "perfect score", 90.6% of the study population made the comparison group, those that did not receive 100% of eligible core measures, only 9.4%. The study considered 100% or less than 100% of eligible core measures. This equation did not take into account what measures individuals did or did not receive. Moreover, co-morbidities making a patient ineligible to receive the measure may have required additional procedures or interventions.

*Recommendations for further study*

Given the single facility of the study, further study of more hospitals of varying types (community, teaching, critical access, non-for-profit, for-profit) should be pursued. Furthermore,

given regional differences in healthcare practices and costs (Sirovich, Gottlieb, Welch, and Fisher, 2006) more hospitals throughout the country should be studied. The study evidences significantly higher hospital costs for male patients than for female patients. These differences are not accounted for by length of stay, APR-DRG severity, or receipt of 100% of eligible core measures. Since the study only analyzed costs associated with those the individual was eligible for, further review of individual treatments received by the men and women should be reviewed. Lastly, since many of the evidenced-based care bundle interventions are predominantly for secondary prevention, more research on long term hospital costs and outpatient costs after initial acute myocardial infarction will be critical to understanding the full financial impact of providing quality acute myocardial infarction care. Eisenstein, et al. (2001) found that total inpatient costs for unstable angina (NSTEMI) and STEMI to be very similar. However, post acute costs were higher for those unstable angina patients than for STEMI patients. Overall, most ACS costs are incurred in the post acute phase further emphasizing the need for implementation of cardioprotective therapies for secondary prevention.

## Conclusion

This study illustrates that providing the highest quality of care for acute myocardial infarction patients, the "perfect score" is not more costly. Heart disease, in which acute myocardial infarction is included, is the number one killer in the United States claiming 654,094 lives in 2004 (Levit, Ryan, Elixhauser, Stranges, Kassed, and Coffey, 2007). As Medicare spending is projected to increase by $425 billion between 2008 and 2017, the economic pressures to contain cost while providing high quality care will come under greater scrutiny. Of particular interest, are the treatment practices among various groups of patients (i.e. males and females, different races, payers, age, etc.). Hospitals need to further examine their evidence-

based care practices, the outcomes and costs in order to meet the needs of their patients and payers.

# References

Abelson, R. (2003). Hospitals Say They're Penalized by Medicare for Improving Care. (Cover story). *New York Times*, *153*(52688), A1-C2. Retrieved Saturday, January 06, 2007 from the Academic Search Premier database.

American Heart Association (2006). Heart Disease and Stroke Statistics-2006 Update. Dallas, Texas. *American Heart Association*. Retrieved October 23, 2008, from http://www.dsf.health.state.pa.us/health/lib/health/epht/heart_disease_and_stroke_stats-2006_update.pdf

Antiplatelet Trialist's Collaboration (1994). Collaborative overview of randomized trials of antiplatelet therapy-I: prevention of death, myocardial infarction, and stroke by prolonged antiplatelet therapy in various categories of patients. *British Medical Journal, 308*: 81-106.

Bramkamp, M., Radovanovic, D., Erne, P., & Szucs, T. (2007, October). Determinants of costs and the length of stay in acute coronary syndromes: a real life analysis of more than 10,000 patients. *Cardiovascular Drugs and Therapy / Sponsored By The International Society of Cardiovascular Pharmacotherapy*, *21*(5), 389-398. Retrieved November 28, 2008, from MEDLINE database.

Brodie, B., Stuckey, T., Wall, T., Kissling, G., Hansen, C., Muncy, D., et al. (1998, November). Importance of time to reperfusion for 30-day and late survival and recovery of left ventricular function after primary angioplasty for acute myocardial infarction. *Journal of The American College of Cardiology*, *32*(5), 1312-1319. Retrieved November 23, 2008, from MEDLINE database.

Carpenter, D. (2006, June). Attention investors. The Q-revolution is spreading. *Trustee: The Journal for Hospital Governing Boards*, *59*(6), 22. Retrieved May 18, 2008, from MEDLINE database.

Centers for Medicare and Medicaid Services (2008). Hospital Quality Initiative Overview: Centers for Medicaid and Medicare Services. Retrieved November 12, 2008, from http://www.cms.hhs.gov/HospitalQualityInits/Downloads/Hospitaloverview.pdf.

Centers for Medicare and Medicaid Services and Joint Commission of Accreditations of Healthcare Organizations (2006, July). Specifications Manual for National Hospital Quality Measures, version 2.0. Retrieved October 23, 2008, from http://qualitynet.org/dcs/ContentServer?cid=1142976368240&pagename=QnetPublic%2FPage%2FQnetTier3&c=Page

Cleverley, W. (2004). Looking ahead to Medicare 2005. *Healthcare Financial Management: Journal of The Healthcare Financial Management Association*, *58*(12), 50-55. Retrieved Sunday, January 14, 2007 from the MEDLINE database.

Correa-de-Araujo, R., Stevens, B., Moy, E., Nilasena, D., Chesley, F., & McDermott, K. (2006, March). Gender differences across racial and ethnic groups in the quality of care for acute myocardial infarction and heart failure associated with comorbidities. *Women's Health Issues, 16*(2), 44-55. Retrieved October 23, 2008, from Academic Search Premier.

Corwin, S. (2006, May 15). Quality over Quantity. Many measures fail to provide accurate reading of a provider's performance. *Modern Healthcare*, 36, 20-20. Retrieved May 18, 2008, from Academic Search Premier database.

Danchin, N., Cambou, J.-P., Hanania, G., Kadri, Z., Genès, N., Lablanche, J.-M. et al. (2005). Impact of combined secondary prevention therapy after myocardial infarction: Data from a nationwide French registry. *American Heart Journal*, 150, 1147-53. Retrieved June 29, 2008, from MEDLINE database.

Eisenstein, E., Shaw, L., Anstrom, K., Nelson, C., Hakim, Z., Hasselblad, V., et al. (2001, August). Assessing the clinical and economic burden of coronary artery disease: 1986-1998. *Medical Care*, *39*(8), 824-835. Retrieved October 23, 2008, from MEDLINE database.

Flather, M., Yusuf, S., Kober, L., Pfeffer, M., Hall, A., Murray, G., et al. (2000, May 6). Long-term ACE-inhibitor therapy in patients with heart failure or left-ventricular dysfunction: a systematic overview of data from individual patients. *Lancet, 355*(9215), 1575. Retrieved November 23, 2008, from Academic Search Premier database.

French, W. (2000, March 9). Trends in Acute Myocardial Infarction Management: Use of the National Registry of Myocardial Infarction. *American Journal of Cardiology*, *85*(5A), 5B. Retrieved November 23, 2008, from Academic Search Premier database.

Healthcare Management Insight (n.d.). Trendstar®: McKesson Corporation. Retrieved October 23, 2008, from http://www.healthcaremanagementinsight.com/HMIProduct/TRENDSTAR.html

Hoffman, Jr., E.D, Klees, B.S., and Curtis, C.A. (2005). Brief summaries of Medicare and Medicaid Title XVIII and Title XIX of The Social Security Act as of November 1, 2005. Office of the Actuary Centers for Medicare & Medicaid Services Department of Health and Human Services. P 3. Retrieved October 15, 2006, from: http://www.cms.hhs.gov/MedicareProgramRatesStats/downloads/MedicareMedicaidSummaries2005.pdf

International Classification of Diseases, Ninth Revision, Clinical Modification (2003). 6th ed. Washington, DC: US Dept of Health and Human Services, Centers for Disease Control and Prevention, Centers for Medicare and Medicaid Services.

Jencks, S., Cuerdon, T., Burwen, D., Fleming, B., Houck, P., Kussmaul, A., et al. (2000, October 4). Quality of Medical Care Delivered to Medicare Beneficiaries. *JAMA: Journal of the American Medical Association*, *284*(13), 1670. Retrieved November 23, 2008, from Academic Search Premier database.

Kandzari, D., Tcheng, J., Grines, C., Cox, D., Stuckey, T. Griffin, J. et al. (2004). Influence of admission and discharge aspirin use on survival after primary coronary angioplasty for acute myocardial infarction. *The American Journal of Cardiology,* 94 (8), 1029-1033. Retrieved June 29, 2008, doi:10.1016/j.amjcard.2004.06.060

Kauf, T., Velazquez, E., Crosslin, D., Weaver, W., Diaz, R., Granger, C., et al. (2006, January). The cost of acute myocardial infarction in the new millennium: evidence from a multinational registry. *American Heart Journal*, *151*(1), 206-212. Retrieved October 23, 2008, from MEDLINE database.

Keehan, S., Sisko, A., Truffer, C., Smith, S., Cowan, C., Poisal, J., et al. (2008, May 2). Health Spending Projections Through 2017: The Baby-Boom Generation Is Coming To Medicare. *Health Affairs, 27*(1/2), w145-w155. Retrieved November 22, 2008, doi:10.1377/hlthaff.27.2.w145

Krause, M.W., Massing, M., Kshirsagar, A., Rosamond, W., & Simpson, R. (2004). Combination therapy improves survival after acute myocardial infarction in the elderly with chronic kidney disease. *Renal Failure,* 26 (6), 715-725. Retrieved June 29, 2008, doi:10.1081/JDI-200037110

Krumholz, H., Anderson, J., Brooks, N., Fesmire, F., Lambrew, C., Landrum, M., et al. (2006, February 7). ACC/AHA clinical performance measures for adults with ST-elevation and non-ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Performance Measures (Writing Committee to Develop Performance Measures on ST-Elevation and Non-ST-Elevation Myocardial Infarction). *Circulation, 113*(5), 732-761. Retrieved November 23, 2008, from MEDLINE database.

Krumholz, H., Chen, J., Murillo, J., Cohen, D., & Radford, M. (1998, March). Clinical correlates of in-hospital costs for acute myocardial infarction in patients 65 years of age and older. *American Heart Journal*, *135*(3), 523-531. Retrieved October 23, 2008, from MEDLINE database.

Krumholz, H., Radford, M., Wang, Y., Chen, J., Heiat, A., & Marciniak, T. (1998, August 19). National use and effectiveness of beta-blockers for the treatment of elderly patients after acute myocardial infarction. *JAMA: Journal of the American Medical Association*, *280*(7), 623. Retrieved November 23, 2008, from Academic Search Premier database.

Levit, K, Ryan K, Elixhauser, A, Stranges, E, Kassed C, Coffey R. *HCUP Facts and Figures: Statistics on Hospital-based Care in the United States in 2005*. Rockville, MD: Agency for Healthcare Research and Quality, 2007. http://www.hcup-us.ahrq.gov/reports.jsp retrieved Sunday, May 18, 2008.

Mahon, N., Rahallaigh, P., O'Sullivan, J., Codd, M., McCann, H., & Sugrue, D. (2000, June). Hospital cost of acute myocardial infarction in the thrombolytic era. *Irish Medical Journal*, *93*(4), 122-122. Retrieved October 23, 2008, from MEDLINE database.

Mason, C. (2005). Medicare Health Care Quality Demonstration: Medicare Modernization Act Section 646. Centers for Medicaid and Medicare Services. Retrieved January 04, 2007, from http://www.cms.hhs.gov/DemoProjectsEvalRpts/downloads/MMA646_Request_for_Information.pdf

Peterson, E., Roe, M., Mulgund, J., DeLong, E., Lytle, B., Brindis, R., et al. (2006, April 26). Association Between Hospital Process Performance and Outcomes Among Patients With Acute Coronary Syndromes. *JAMA: Journal of the American Medical Association*, *295*(16), 1912-1920. Retrieved June 13, 2008, from Academic Search Premier database.

Polverejan, E., Gardiner, J., Bradley, C., Holmes-Rovner, M., & Rovner, D. (2003, November). Estimating mean hospital cost as a function of length of stay and patient characteristics. *Health Economics*, *12*(11), 935-947. Retrieved November 28, 2008, from MEDLINE database.

Premier, Inc. (2008, November). [Average length of stay for ICD-9 410.xx principal diagnosis-all hospitals in Premier database discharges August 2006 to December 31, 2007.] Unpublished raw data.

Premier, Inc. (2008, May). *GrouperMethology.* Clinical Advisor Reference Manual: Methodologies. Retrieved November 23, 2008, from https://informaticsbeta.premierinc.com/microstrategy/asp/Main.aspx?pg=subProduct&slice=1&parAppId=&prCrumbId=0#

Premier, Inc. (n.d.). Mission/Vision: What Premier does. Retrieved December 11, 2008, from http://www.premierinc.com/about/mission/index.jsp

Premier, Inc. (n.d.). Quality Measures Reporter. Retrieved October 23, 2008, from http://www.premierinc.com/quality-safety/tools-services/performance-suite/QMR_21907v2.pdf

Schoenenberger, A., Radovanovic, D., Stauffer, J., Windecker, S., Urban, P., Eberli, F., et al. (2008, March). Age-Related Differences in the Use of Guideline-Recommended Medical and Interventional Therapies for Acute Coronary Syndromes: A Cohort Study. *Journal of the American Geriatrics Society*, *56*(3), 510-516. Retrieved November 12, 2008 from MEDLINE database.

Sirovich, B.E., Gottlieb, D.J., Welch, H.G., and Fisher, E.S. (2006). Regional variations in health care intensity and physician perceptions of quality of care. *Annals of Internal Medicine*, 144(9), 641-649.

Spencer, F., Lessard, D., Yarzebski, J. Gore, J. & Goldberg, R. (2005). Decade-long changes in the use of combination evidence-based medical therapy at discharge for patients surviving acute myocardial infarction. *American Heart Journal,* 150, 838-44. Retrieved June 29, 2008, from MEDLINE database.

Szekendi, M. (2003). Compliance With Acute MI Guidelines Lowers Inpatient Mortality. *Journal of Cardiovascular Nursing*, *18*(5), 356-359. Retrieved Thursday, January 04, 2007 from the Academic Search Premier database.

Tiemann, O. (2008, January). Variations in hospitalisation costs for acute myocardial infarction - a comparison across Europe. *Health Economics, 17*(1 Suppl), S33-45. Retrieved October 23, 2008, from MEDLINE database.

Tran, C.T.T., Laupacis, A., Mamdani, M., & Tu, J.V. (2004). Effect of age on the use of evidence-based therapies for acute myocardial infarction. *American Heart Journal*, 148, 834-41. Retrieved June 29, 2008, from MEDLINE database.

Udvarhelyi, I., & Gatsonis, C. (1992, November 11). Acute myocardial infarction in the Medicare population. *JAMA: Journal of the American Medical Association*, *268*(18), 2530. Retrieved November 28, 2008, from Academic Search Premier database.

U.S. Census Bureau, Population Division, Special Populations Branch (2000). *Population 65 Years and Over, for States and for Puerto Rico: 1990 and 2000.* Retrieved October 15, 2006 from: http://www.census.gov/population/www/cen2000/phc-t13.html

Weech-Maldonado, R., Neff, G., & Mor, V. (2003). The relationship between quality of care and financial performance in nursing homes. *Journal Of Health Care Finance, 29*(3 (Print)), 48-60. Retrieved Thursday, January 04, 2007 from the MEDLINE database.

Yusuf, S. (2002, July 6). Two decades of progress in preventing vascular disease. Lancet, 360(9326), 2. Retrieved November 13, 2008, from Academic Search Premier database.

Appendix A

**Acute Myocardial Infarction Measure Population**

The acute myocardial infarction (AMI) measure population can be initially identified by four data elements that are common to all of the performance measures in the set:

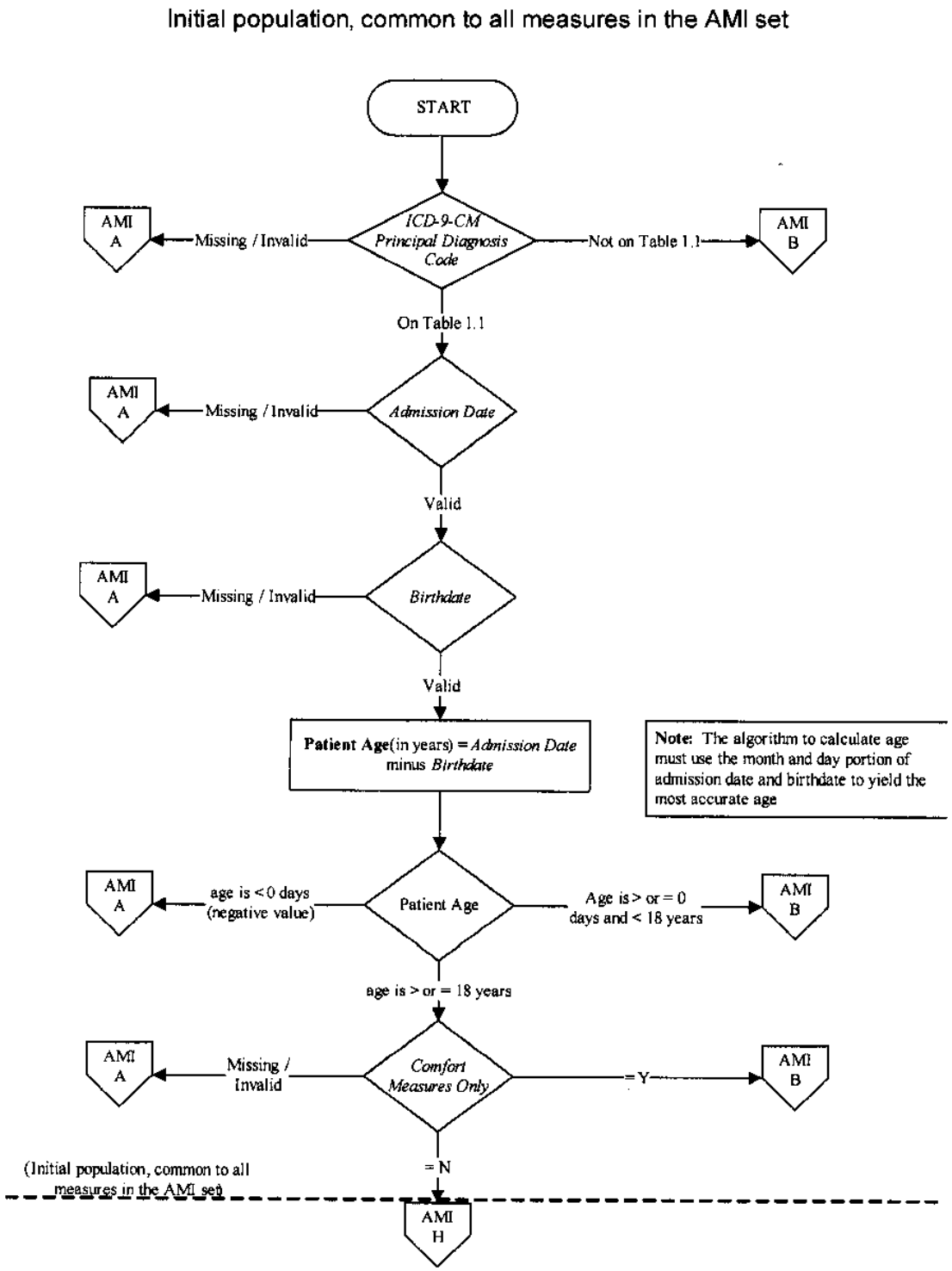
- *Admission Date*
- *Birthdate*
- *Comfort Measures Only*
- *ICD-9-CM Principal Diagnosis Code*

An *ICD-9-CM Principal Diagnosis Code* of AMI is required for inclusion in the population as identified on Table 1.1 in Appendix A. The patient age must be 18 years of age and older. The population for this measure set includes only patients admitted to the hospital for inpatient acute care.

Patients who have physician orders for *Comfort Measures Only* are excluded from the AMI measure population. These patients receive palliative care and usual interventions are not received because a medical decision was made to limit care.

The following algorithm should be used to process all records in the AMI national quality measure set. Records with a measure category assignment of "B" (not in measure population) will not need to be processed through individual measure algorithms. Records with a measure category assignment of "A" (missing or invalid population data) will also not need to be processed through the individual measure algorithms. However, the total count of records with an "A" category assignment must be added to the "A" count (number of cases with missing/invalid population) for each individual measure. This will provide a total count of all records that could not be processed through each measure due to missing or invalid data. (Performance measurement systems need to refer to the *ORYX® Data Quality Manual* for greater detail.)

Appendix B


Initial population, common to all measures in the AMI set
START
ICD-9-CM Principal Diagnosis Code
Missing / Invalid
AMI A
Not on Table 1.1
AMI B
On Table 1.1
Admission Date
Missing / Invalid
AMI A
Valid
Birthdate
Missing / Invalid
AMI A
Valid
Patient Age(in years) = Admission Date minus Birthdate
Note: The algorithm to calculate age must use the month and day portion of admission date and birthdate to yield the most accurate age
Patient Age
age is < 0 days (negative value)
AMI A
Age is > or = 0 days and < 18 years
AMI B
age is > or = 18 years
Comfort Measures Only
Missing / Invalid
AMI A
= Y
AMI B
= N
(Initial population, common to all measures in the AMI set)
AMI H